(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 399 200 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
18.06.1997 Bulletin 1997/25

(51) Int Cl.[6]: **H04N 7/16**

(21) Application number: **90107108.4**

(22) Date of filing: **12.04.1990**

(54) **Functionally modifiable cable television converter system**

Kabelfernsehkonvertersystem mit modifizierbarer Funktion

Système convertisseur pour télévision par câble fonctionnellement modifiable

(84) Designated Contracting States:
AT BE CH DE DK FR GB IT LI NL SE

(30) Priority: **25.05.1989 US 357174**

(43) Date of publication of application:
28.11.1990 Bulletin 1990/48

(60) Divisional application: **96108778.0**

(73) Proprietor: **GENERAL INSTRUMENT CORPORATION OF DELAWARE**
Chicago, Illinois 60602 (US)

(72) Inventors:
- **Kauffman, Marc W.**
Cheltenham, Pennsylvania 19012 (US)
- **Miller, Michael R.**
Moorestown, New Jersey 08057 (US)

(74) Representative: **Hoeger, Stellrecht & Partner**
Uhlandstrasse 14 c
70182 Stuttgart (DE)

(56) References cited:
EP-A- 0 132 401
EP-A- 0 187 973
GB-A- 2 118 750
US-A- 4 623 920
US-A- 4 710 955

- **FUNKSCHAU, no. 5, 24th February 1989, pages 59-62; C. SCHEPERS: "Der Schlüssel zum Scrambling-Problem?"**

EP 0 399 200 B1

Description

The present invention relates to cable television apparatus, and more particularly to a converter with remotely modifiable functionality provided by downloadable firmware.

Cable television converters are currently available that allow a cable system operator to remotely control subscriber service authorizations from a central "headend" site. These units, which are commonly referred to as "addressable converters", allow the cable system operator to control access to various premium services by sending a control signal from the headend to individual converters located at subscribers' homes. The authorization signals are carried on the cable television system, and enable individual subscribers to view programs that they pay an additional fee for. In operation, the control signals typically enable the converter to descramble the premium channels for viewing by the subscriber.

Other addressable systems currently available allow a limited set of operational parameters to be downloaded to a converter from the headend. Such operational parameters include, for example, information that maps displayed channels to tuned channels, time-out periods, barker channel(s), the converter output channel, the terminal configuration, and enable/disable functions for subscriber features such as remote hand-held control, parental control, favorite channel recall, volume control, and the like. The current state of the art is to download configuration information for a set of features that have been predetermined at the time of manufacture or installation of the cable television converter. An example of such a converter is the Model DPV7200 addressable converter manufactured by the Jerrold Division of General Instrument Corporation, Hatboro, Pennsylvania, U.S.A.

Other systems with downloadable data capabilities are also known. U.S. Patent 4,054,911 to Fletcher, et al. relates to an information retrieval system capable of capturing packets or rows of video displayable data and/or control program instructions from data continuously transmitted in a common predetermined format. In the system disclosed in the patent, a user decides what information is to be retrieved, and takes action to cause a terminal to retrieve that information. Although a user can vary the function of the terminal by capturing different transmitted data, it is the user that determines what video displayable information is to be received, and how the terminal which receives this information is to process it. There is no disclosure or provision of means to enable a system operator to establish the functional operation of individual terminals on a multi-terminal network.

In commonly owned U.S. Patent 4,712,239 to Frezza, et al. entitled "Security Arrangement for Downloadable Cable Television Converters", incorporated herein by reference, a downloadable converter is disclosed that prevents a false booter image from being downloaded. A false image could subject the system to various integrity problems, such as enabling an unauthorized user to view premium programs. In the patented system, a booter image is received on one channel and a checksum is computed there from. A valid checksum, extracted from tag data transmitted on a separate channel and associated with a scrambled program signal, is compared with the computed checksum. If the checksums do not match, a descrambler in the converter is precluded from descrambling the program signal. The system disclosed in this patent downloads all of the operating software to a cable television converter over a dedicated "booter channel", to which the converter is force tuned when first turned on. After the download is complete, the converter's data receiver is returned to the regular data channel, where it remains until the converter is turned off.

US-A-4,623 920 discloses a cable television converter comprising:

means for receiving functional operating software (firmware) downloaded from a remote cable television headend;
means coupled to said receiving means for storing said downloaded functional operating software (firmware);
means for verifying said downloaded functional operating software (firmware) and
processor means coupled to said storing means for accessing and executing said downloaded functional operating software (firmware).

EP-A-0 187 973 discloses a cable television converter comprising processor means and a stored algorithm for descrambling a scrambled television channel. For enabling the descrambling the processor means receive an address word and in addition a coded starting word. The starting word is comprising the starting address for decoding.

EP-A- 0 132 401 discloses a cable television converter which is supplied with at least two keys from the transmitting side for reproducing a transmitted information by using the two keys.

US-A- 4,710,955 discloses a cable television converter for receiving a scrambled television signal. This signal is selectively descrambled in response to subscriber action. The signal received from the headend is monitored by the subscriber terminal for a call-in command which instructs the subscriber terminal to forward the record of billable programs to the headend over a telephone communication path. Transaction credits can be downloaded from the headend to the subscriber terminal.

In Funkschau, No. 5, 24th February 1989, pages 59-62; C. Schepers: "Der Schlüssel zum Scrambling Problem?" a converter is disclosed which receives keying information as well as addressable data for operation of the descrambler.

GB-A-2 118 750 discloses a converter receiving op-

tion address data which are stored into the subscriber stations over the network from a headend. The data can be control signals for controlling the descrambling of premium TV-signals, software for operating a microcomputer, data to facilitate selection of particular TV channels depending on service paid for, etc.

The problem of the present invention is to provide a method and a system for remotely modifying the functionality of a cable television converter or other terminal which is more acceptable for a user.

According to the present invention this problem is solved by a remotely controllable cable television converter which is able to operate in a baseline mode allowing the reception of a television program and which, upon receipt of functional operating software (firmware) downloaded from a remote cable television headend, can be provided with higher levels of converter functions resulting in an increased converter functionality in addition to said baseline mode, said converter comprising:

means for receiving said functional operating software (firmware) downloaded from said remote cable television headend;
means coupled to said receiving means for storing said downloaded functional operating software (firmware);
means for verifying said downloaded functional operating software (firmware);
processor means coupled to said storing means for accessing and executing said downloaded functional operating software (firmware);
nonvolatile memory means coupled to said processor means for storing default operation software, said default operation software providing said baseline mode operation to said converter; and
means responsive to said verifying means for causing said processor means to execute said default operation software instead of said downloaded functional operating software (firmware) in the event the downloaded software is invalid or contains errors.

Further advantageous embodiments are subject matter of claims 2 to 20.

Due to the fact that according to the present invention the downloaded functional operating software is subject to some kind of verification proceedings by said means for verifying, it can occur that no functional operating software is available at the converter. If then the system is not able to reproduce any television program, but only for example snow on the screen or blanking as known from converters according to prior art, the cable television converter will not be acceptable for a user.

According to the present invention, acceptability of the system is achieved by providing the converter with baseline operational characteristics so that the user is always enabled to still receive at least one television program even though the downloaded operational software is not received.

In addition, the inventive concept enables the operator to provide a more intensive verification of the downloaded functional operation software, a proceeding which is necessary as a security feature to guard against infiltration of the converter by a "software pirate".

It is an advantage to have a method and system for downloading firmware to a remote terminal, such as a cable television converter, which allows modification of virtually any or all firmware functions of the terminal by the system operator. It is further advantageous for such a method and system to enable the system operator to replace or modify options that were predetermined at the time of manufacture or installation of the terminal. By effecting terminal modifications automatically from a headend location, such a method and system eliminates the need for a technician to travel to a subscriber's home to modify or physically replace a subscriber's terminal to effect such functional modifications.

In accordance with a preferred embodiment of the present invention, a cable television converter with remotely modifiable functionality is provided. The converter includes means for receiving functional operating software (firmware) downloaded over a cable television network, and means coupled to the receiving means for storing the functional operating software (firmware). Means are provided for verifying the integrity of the functional operating software (firmware), and processor means coupled to the storing means accesses and executes the functional operating software (firmware) to provide one or more converter functions dictated by the functional operating software (firmware). Nonvolatile memory means are coupled to the processor means for storing default operation software for the converter. Means responsive to the verifying means cause the processor means to execute the default operation software, instead of the downloaded functional operating'software (firmware), in the event the integrity of the functional operating software (firmware) is not verified.

Data receiving means are provided in accordance with a further embodiment for obtaining instructions downloaded over a cable television network. Downloaded functional operating software (firmware) is received and stored by the converter only in response to specific instructions received by the data receiving means.

The functional operating software (firmware) receiving means and data receiving means can comprise a frequency agile data receiver, together with means for selectively tuning the receiver, to receive instructions on a first channel and downloaded functional operating software (firmware) on a second channel.

In a further embodiment timer means return the receiver to the first channel if the receiver has been tuned to the second channel for predetermined time period. The predetermined time period may be specified in instructions received on said first channel, and the length of the time period may be dependent on an amount of functional operating software (firmware) to be received.

In this manner, a converter will not become stuck on the second channel by error, and be rendered unable to receive further instructions on the first channel.

The downloaded functional operating software (firmware) received and stored by the converter can implement a functional layout on a keyboard associated with the converter. Functional operating software (firmware) can also implement a feedback function, such as an LED (light-emitting-diode) display or on-screen display to assist a user in operating the converter. A control function for a video recorder coupled to the converter can also be implemented by the functional operating software (firmware). Similarly, the functional operating software (firmware) can implement a communication protocol for the converter, a descrambling technique for the converter, an on-screen display to be provided by the converter to a television coupled thereto, and/or a user interface to services provided over the cable television network.

In a further preferred embodiment of the present invention, functional operating software (firmware) is transmitted in an encrypted form, and the instructions contain a key for decrypting the functional operating software (firmware). The functional operating software (firmware) may also be received by the converter in a plurality of segments, with the instructions identifying the number of segments to be received for a complete functional operating software (firmware) download. Means can be provided for determining if all of the segments have been validly received, and for receiving replacement segments if one or more segments of the functional operating software (firmware) have not been validly received. Receipt of firmware can be prevented if the number of segments identified by the instructions is greater than a predetermined limit.

According to a further preferred embodiment a method for providing the cable television converter with functions dictated by downloaded functional operating software (firmware) is also provided. Converter control data is received from a remote location via a cable television network. A designated functional operating software (firmware) package is captured from a set of functional operating software (firmware) packages carried on the cable television network, in response to instructions contained in the converter control data. The designated functional operating software (firmware) package is stored in a memory provided in the converter, and is executed to provide at least one converter function dictated thereby.

The functional operating software (firmware) packages may be carried on the cable television network in encrypted form, and decrypted using a key contained in the converter control data. In one embodiment, the converter control data is received on a first data channel and the functional operating software (firmware) packages are captured from a second data channel on the cable television network. The first channel is monitored to receive converter control data, and the second channel is tuned to capture functional operating software (firmware) upon receipt of appropriate instructions on the first channel. Reception is returned to the first channel after the functional operating software (firmware) is captured. If the functional operating software (firmware) has not been captured within a predetermined time period, reception switches back to the first channel from the second channel.

In accordance with another embodiment of the present invention, a remotely modifiable converter (user terminal) is provided which comprises means for receiving a plurality of cyclically transmitted functional operating software (firmware) segments, the segments together comprising a functional operating software (firmware) package. Means coupled to the receiving means verify each segment upon receipt thereof, and means are provided for storing each verified segment. A determination is made as to whether a complete functional operating software (firmware) package has been stored in the storing means at the completion of a functional operating software (firmware) transmission cycle. If not, then reception, verification, and storage of transmitted functional operating software (firmware) segments continues during a subsequent functional operating software (firmware) transmission cycle. Reception of the functional operating software (firmware) segments is terminated upon a finding that a complete functional operating software (firmware) package has been stored. Means can further be provided for precluding the execution of functional operating software (firmware) segments until a complete functional operating software (firmware) package has been stored.

The verifying means can operate by testing a checksum for each functional operating software (firmware) segment as it is received. The converter (terminal) may further comprise means for maintaining a record of the proper checksum for each segment, and means for periodically retesting the checksums after a complete functional operating software (firmware) package has been stored. Default operation software may be stored for the converter (terminal), and executed if the checksums are not verified upon retesting. The complete functional operating software (firmware) package may also be verified after it has been stored, and the default operation software executed if the complete functional operating software (firmware) package is not valid. The default operation software may also be executed if reception of functional operating software (firmware) segments is not completed during a predetermined time period.

A complete functional operating software (firmware) package may include a plurality of modules. Execution of fewer than all of the modules may be precluded as an additional security feature.

Further features and advantages of the present invention are subject matter of the following description of embodiments and the drawings.

Figure 1 is a block diagram of a functionally modifiable cable television converter system in accordance with the present invention;

Figure 2 is a block diagram of the pertinent elements of a converter used in connection with the system of the present invention;

Figure 3 is a flowchart illustrating steps taken by the headend when it receives a new firmware package or an assignment to download firmware to a converter;

Figure 4 is a flowchart illustrating the continuous transmission of firmware over a secondary data channel;

Figure 5 is a flowchart illustrating the steps taken by a converter in receiving downloaded firmware; and

Figure 6 is a flowchart illustrating the periodic reverification of downloaded software by a converter.

Turning to Figure 1, a cable television system is depicted having headend components, generally designated 10 and subscriber components, generally designated 12. The headend communicates with the subscriber via a distribution cable 36. A firmware development system 16 is used to create new functional firmware packages for subscriber terminals, such as converter 40. Firmware development system 16 may be physically located at the headend, but is more typically located at the facilities of a vendor which develops new firmware programs for sale to a cable system operator. New firmware packages may be transferred to an addressable controller 14 located at the headend by magnetic tape 20 which is read by addressable controller 14, or by communication between the firmware development system 16 and addressable controller 14 via direct connection or modems 18 operating over conventional telephone lines. Those skilled in the art will recognize that other means may also be available for transferring firmware from firmware development system 16 to addressable controller 14.

Once firmware is resident in addressable controller 14, it is transmitted repeatedly over a data channel. The data channel may be either the primary addressable data channel provided in a conventional cable television network having addressable converters, or a separate secondary data channel. In either event, the data channel(s) can transmit the data on an FSK modulated FM carrier or by any other suitable transmission scheme well known in the art.

The use of a secondary channel for downloading firmware to converters is illustrated in Figure 1. Control signals, including data such as converter addresses, program authorization codes, and the like is communicated from addressable controller 14 to a converter 40 via control data modulator 26. The output of control data modulator 26 is coupled to distribution cable 36 via a tap 34, and data is received therefrom by converter 40 via tap 38. The control data modulator transmits the data signals on a primary channel, and in accordance with the present invention, the data includes instructions to converter 40 which cause the converter to receive specified firmware downloaded from addressable controller 14.

In the two channel embodiment illustrated in Figure 1, the firmware is transmitted on a secondary channel by firmware modulator 24, coupled to the cable network at tap 30. Upon receipt of instructions on the primary channel, converter 40 switches to the secondary channel for receipt of designated firmware. An additional data path 28 may optionally be provided via tap 32 for receipt of data from converter 40 by addressable controller 14. Such data might include, for example, a verification that converter 40 has successfully received a firmware package it has been instructed to receive. The provision of a return path 28, which provides a "two-way" cable communication system, is well known in the art.

Billing system 22 is provided at the headend for maintaining accounting information relating to charges incurred by subscribers on the cable system. In accordance with the present invention, different firmware packages downloaded by headend 10 to converter 40 may provide different converter functions, with higher levels of service providing increased converter functionality. Billing system 22 keeps track of the level or service for each subscriber, and assigns particular firmware packages to subscriber converters on the basis of converter functionality to be provided to each subscriber.

At the subscriber location 12, a subscriber may have one or more video appliances 42, 44 coupled to the output of converter 40. For example, video appliance 42 might be a television set, and video appliance 44 might be a video recorder ("VCR"). In accordance with the present invention, firmware downloaded to converter 40 can provide functions relating to a VCR. An example of such a function is time controlled programming. This function enables the converter to be programmed to make channel changes at various times so that the VCR can record different television programs on different channels automatically and while unattended. Such a function can also enable "impulse pay-per-view" orders to be programmed into the converter by a subscriber, so that special premium programs can be ordered, when the subscriber is not home, and recorded on the subscriber's VCR for later viewing.

Figure 2 is a block diagram illustrating the pertinent components in one embodiment of a converter 40 in accordance with the present invention. In the embodiment illustrated, the converter receives addressable data on one data channel and downloaded firmware on another data channel. It is noted that in another embodiment of the invention, both the addressable data and the firmware can be received over a single data channel. Or, the firmware may be carried on some other media, such as the public telephone network.

In the two channel embodiment illustrated in Figure 2, a microprocessor 50 receives data from cable 36 via

a frequency tunable receiver 52. A transmitter 61 and return path 62 can be provided from microprocessor 50 back to addressable controller 14 in the event the converter is used with a two-way cable television system. Like receiver 52, transmitter 61 can be frequency tunable to enable a choice of return transmission frequencies.

A tuner 54, under the control of microprocessor 50, tunes frequency tunable receiver 52 to either a primary channel for receipt of addressable data (e.g., instructions to capture a particular firmware package) or to a secondary channel for the receipt of firmware. Although a single secondary channel is described herein for purposes of illustration, it will be appreciated that any number of such secondary channels can be provided, depending on system requirements. Typically, frequency tunable receiver will be tuned to the primary channel, and will only switch to the secondary channel upon specific instructions contained in data received on the first channel. In the alternate embodiment where both addressable data and firmware are received on a single data channel, frequency tunable receiver 52 and tuner 54 can be replaced with a fixed frequency data receiver.

The provision of a dedicated secondary data channel as illustrated in Figure 2 is advantageous. By keeping firmware data off of the primary channel, the data throughput load on this channel is reduced.

In the two channel embodiment, firmware data is broadcast cyclically on the second channel, by addressable controller 14 at the headend. In a preferred embodiment, a plurality of different firmware packages are broadcast on the secondary channel, each package providing different converter functions or combinations of functions. Upon receipt of instructions on the primary channel, microprocessor 50 will cause tuner 54 to switch receiver 52 to the secondary channel for receipt of a designated firmware package.

Various memory devices are coupled to microprocessor 50, including read only memory ("ROM") 56, operating random access memory ("RAM") 58, and nonvolatile firmware RAM 60. ROM 56 contains a program that allows converter 40 to retrieve and execute a downloaded firmware package. Upon receiving the proper command from the addressable controller, the converter aborts any downloaded package currently being executed, accesses the appropriate data channel for receipt of a designated firmware package to be downloaded, and receives and loads the firmware into nonvolatile firmware RAM 60.

ROM 56 also contains default operation software, which is used to restore the converter to a nominal or "baseline" operation if a bad firmware download occurs. As explained below, if an error is detected in the receipt of downloaded firmware, or if the firmware is found to be invalid, the converter is forced to execute only the default operation software stored in ROM 56.

A timer 64 is associated with microprocessor 50 to provide a time-out feature that prevents the converter from getting stuck on the secondary channel, in the event there is a problem receiving specified firmware.

When billing system 22 assigns a new firmware package to a particular converter 40, addressable controller 14 is commanded to transmit instructions to the converter. The instructions are received by microprocessor 50, and include an identifier specifying which firmware package to receive, where to find the firmware package (i.e., on the primary or a specified secondary channel), a predetermined time limit defining how long the converter should attempt to receive the firmware before aborting, a key to use in decrypting the data in the event it is encrypted, and the maximum segment number to be loaded (indicating how many segments are included in the firmware package to be received). While the firmware is being received, timer 64 counts down the time-out period specified in the download command. If the timer expires, microprocessor 50 aborts the download, and returns to the original data channel. The time-out period specified in the download command can be varied depending on the amount of firmware to be downloaded.

Timer 64 is also used in connection with a self-check that is periodically performed by the converter to ensure that the firmware has not changed since the last authorized download. This self-check is a security feature to guard against infiltration of the converter by a "software pirate" who attempts to download unauthorized software to the converter, in an effort to steal services from the cable system.

In accordance with the self-check procedure, timer 64 retests the checksum for each of the firmware segments at regular intervals after the firmware has been downloaded. In the event a checksum is found to be invalid, microprocessor 50 restores the converter to baseline operation by executing the default operation software contained in ROM 56.

Converter 40 contains various other components with functions that can be modified by downloaded firmware. For example, a light-emitting-diode ("LED") display or other display 66 may be provided on the converter to give a user feedback concerning converter operations. Pressing a button on the converter, or its remote control unit, can cause an LED to light, verifying that the button has been pressed or that a function to be activated by the button has occurred. Such a feedback function is useful to assist a user in operating the converter.

The converter also includes a keyboard 68, the functional layout of which can be defined and/or modified by firmware downloaded to the converter. Keyboard 68 may be physically on the converter box, on a remote hand-held unit for the converter, or a separate keyboard can be provided in both places.

Converter 40 also includes a descrambler 70 for descrambling premium programs received via the cable television network. Various descrambling techniques are well known in the art, and different techniques can

be implemented by downloading different firmware to the converter.

Another feature that can be provided by converter 40 is the display of information on a user's television set. On-screen display driver 72 is provided for this purpose. An example of such a display is the channel number tuned to, or the current time. In addition, on-screen displays can be used to distribute messages from the cable system operator, e.g., "your account is past due; please send us a check". An electronic mail, or "E-mail" feature can also be provided, enabling a subscriber to send and receive text messages on his television (or other display) via the cable system. The implementation and/or modification of on-screen displays can be provided by firmware downloaded to the converter.

In order to provide a measure of protection against illegal use of the firmware download feature, the firmware is downloaded to the converter in an encrypted form. The data is decrypted at the converter by a decryption module 74. A decryption key is transmitted to the converter from the headend as part of the addressable data instructions that command the converLer to receive a particular firmware package. Encryption and decryption schemes are well known in the art. Examples of such schemes are provided in commonly owned U. S. Patent Nos. 4,638,356 of William A. Frezza, entitled "Apparatus and Method for Restricting Access to a Communication Network", and 4,710,955 of Marc W. Kauffman, entitled "Cable Television System with Two-Way Telephone Communication Path". Both of these patents are incorporated herein by reference.

A viewership monitor 76 can be provided in accordance with the present invention to enable a cable system operator to determine what programs and services a subscriber has received using each converter, and/or to retrieve a list of the functions which have been used on each converter. Viewership monitor 76 will monitor the operation of the converter, and store pertinent data relating thereto. By addressing an appropriate command to the converter, the cable system operator will be able to upload the data to the headend for analysis.

Other functions that can be implemented by firmware downloaded to the converter include communication protocols for the converter, and user interfaces to services provided over the cable television network. For example, a user may be provided with the capability to order pay-per-view programs on an impulse basis. The procedure for ordering such programs can be modified through downloadable firmware. Utility meter reading can also be provided, by adding an asynchronous data port to the converter and controlling the retrieval of utility data via downloaded firmware.

A flowchart illustrating a routine which can be used by the addressable controller in connection with the receipt and downloading of firmware is provided in Figure 3. The routine begins at box 80, and at box 82 a determination is made as to whether a firmware update has been received from the firmware development system. If so, control passes to box 84 and the new firmware data is encrypted. At box 86, the encrypted data is loaded into the secondary data channel transmitter (firmware modulator 24) and continuously transmitted on the secondary channel together with other firmware packages that can be provided to converters on the system.

At box 88, a determination is made as to whether a new firmware package assignment has been made by billing system 22. If so, addressable controller 14 sends an appropriate command on the primary channel (control data modulator 26) as indicated at box 90. The command is addressed to the particular converter that is to receive the firmware, and identifies the channel the firmware is to be received from, identifies the firmware package to be received, provides the decryption key necessary to decrypt the firmware data, identifies the number of segments which make up the complete firmware package, and sets forth the time-out parameter defining the maximum time the converter should stay tuned to the secondary channel for receipt of the downloaded firmware.

The converter receives the firmware in fixed length "segments", and specific converter models will have specific maximum segment numbers determining the actual maximum size of allowable firmware downloads. In a preferred embodiment, the maximum segment number is a hard-coded parameter. Should an attempt be made to download firmware that exceeds the maximum size, the download will be rejected by the converter. In operation, the converter will ignore the download command and will not switch to the secondary channel if the transmitted maximum segment number parameter exceeds the internal converter maximum.

At box 92 of Figure 3, a determination is made as to whether an abort of a download is required. This would be the case, for example, if the addressable controller detects a problem with an attempted download. In the event an abort is required, an abort command is transmitted over the secondary channel as indicated at box 94. The converter will then switch back to the primary channel, execute the default operation software to return to a baseline operation, and await a subsequent command from the addressable controller via the primary data channel. At box 96, the routine of Figure 3 ends. It will be appreciated by those skilled in the art that the routine of Figure 3 is called on a periodic basis (or can be a continuous loop) to enable new firmware to be received from the firmware development system and to download firmware packages to converters at the command of billing system 22.

Figure 4 illustrates a routine that the addressable controller can use to continuously transmit firmware data over the secondary channel. The routine commences at box 100, and at box 102 data is transmitted over the secondary channel. At box 104, a determination is made as to whether the last segment of a firmware package has been transmitted. If not, transmission of the remain-

ing segments continues as indicated at box 102. Once the last segment has been transmitted, control passes to box 106 and the addressable controller transmits a check/execute command to the converter(s) that was to receive the firmware package. The check/execute command includes the firmware package number that was to be received, and a check pattern. The check pattern is used to verify the entire download prior to execution. When a check/execute command is received, the converter checks to see if all required segments have been received, and that the check pattern downloaded matches the pattern calculated from the actual downloaded data. If all checks are valid, the converter permits execution of the downloaded code, and returns to the primary data channel. After the check/execute command is sent at box 106 of Figure 4, control returns to box 102, and continuous transmission of the data proceeds over the secondary channel.

Figure 5 is a flowchart illustrating the capture of downloaded firmware by a converter. The routine begins at box 110, and control passes to box 112 where a determination is made as to whether a firmware capture command has been sent to the converter. If not, the converter continuously waits for such a command to be received at box 112.

Once a firmware capture command is received, control passes from box 112 to box 120 for the actual capture of the firmware. At the same time, an ancillary time-out process commences as indicated at boxes 114, 116, and 118. A timer counts down the time-out period specified in the firmware capture command. If the time-out period expires before the specified firmware package has been successfully captured, as determined at box 114, control passes to box 116 where the download is aborted and the converter returns to the primary data channel. As indicated at box 118, the default operation software is executed so that the converter can operate in a baseline mode until the appropriate firmware package can be properly downloaded.

As indicated at box 120, before a firmware download commences, a determination is made as to whether the number of segments contained in the firmware package to be downloaded is within bounds. In other words, as noted above, the maximum segment number of the firmware package to be downloaded must not exceed the maximum size allowable for the converter. If the number of segments exceeds the number allowed by the converter, the firmware capture command is ignored and control returns to box 112. Otherwise, the firmware capture proceeds and at box 122, the converter switches to the secondary channel (i.e., the channel on which the firmware is downloaded). At box 124, the segments comprising the firmware package are received. Firmware is continuously broadcast on the secondary data channel in small (e.g., 32 byte) encrypted packets. A converter that has been commanded to accept a new package tunes to the appropriate channel and loads each packet that has the proper version identifier. While loading, the converter keeps track of each segment successfully loaded in an internal segment bit map. As indicated at box 126, a determination is made as to whether a segment has been successfully loaded. This is accomplished by computing a checksum for each segment, and comparing the checksum with one downloaded with the firmware segment. If the checksums match, the converter decrypts the data contained in the segment, stores the data, and sets an appropriate bit in a firmware segment bit map as indicated at box 130. In storing the data, if prior firmware has been stored in the converter, the appropriate segment of the prior firmware is overwritten with the newly received data.

If it is determined at box 126 that a segment has not been properly loaded (i.e., the computed and downloaded checksums do not match), the converter ignores the segment and proceeds directly to box 132. At box 132, a determination is made as to whether the last segment in a firmware package has been received. If not, control returns to box 124 and the procedure continues until all segments are received.

After the last segment has been received, control passes to box 134 which determines if the bit map created at box 130 is complete. If the bit map is not complete, it means that one or more segments were not properly loaded and an attempt to receive these segments will be made during the next transmission cycle of the firmware. In this event, control returns from box 132 to box 124 where an attempt to receive the entire firmware package will again be made.

As is evident from the flowchart of Figure 5, an incorrectly received segment will not overwrite a previously correctly received segment. All correctly received segments, however, will overwrite previously received segments. In this manner, even if there are errors in the transmission of certain segments during a download cycle, all of the segments should be correctly received after the completion of several complete transmission cycles of a firmware package.

Once all of the segments have been properly received, the bit map will be complete, and box 134 will pass control to box 136. Box 136 responds to the check/execute command transmitted by the addressable controller at box 106 in Figure 4. When the check/execute command is received, the converter checks to see if all required segments have been received and that the check pattern downloaded matches a pattern calculated from the actual downloaded data (i.e., the complete firmware package). If the patterns do not match, control returns to box 124 and additional attempts are made to receive the firmware as long as a time-out (box 114) has not occurred.

If the entire firmware package is determined to be valid at box 136, control passes to box 138 and an execution bit is set permitting the firmware to be executed. As an additional level of protection against a software pirate, software contained in the converter's ROM (ROM 56 - Figure 2) can periodically determine if all of the func-

tional modules contained in the firmware package are being executed, and if not, subsequent execution of the firmware can be precluded by turning off a separate, special execution bit maintained by the converter.

At box 140, the downloading of a firmware package is complete, and the converter returns to the primary data channel. The routine ends at box 142.

The firmware download process is a destructive one. Once a converter receives the command to accept a new package, the old downloaded firmware (if any) is effectively deleted and cannot be executed. In the preferred embodiment, partial downloads are not supported, and an entire package must be sent. This further frustrates a software pirate's efforts, and allows a firmware download to be nullified by sending the command to accept a package immediately followed by sending the command to return to the primary data channel.

The various commands sent by the addressable controller to support the firmware download process are:

Accept Firmware Download
Return to Primary Channel
Disallow Downloaded Execution
Load Firmware Segment
Check/Execute Firmware
Send Firmware Check Pattern

The "Accept Firmware Download" command is used to initiate the firmware download process. It may be sent to one individual converter or globally to a set of converters that understand a group address. The addressed converter(s) prepares to accept the package number, on the appropriate channel, using the given firmware decryption key and maximum segment number. The firmware download time-out value is also given. Upon reception of this command, the converter goes into its firmware download mode, in which it must not execute any downloaded code.

The "Return to Primary Channel" command is used to force a converter to return to the primary data channel. This command may also be sent in a specific format to an individual converter, or in group format to a set of converters. All converters receiving this command abort the current firmware download, clear their firmware segment bit maps, and exit the firmware download mode.

The "Disallow Downloaded Execution" command explicitly disallows the execution of any downloaded firmware. It may be sent in the specific or group format. All converters receiving this command abort execution of any downloaded firmware, clear their firmware segment bit maps, exit firmware download mode, and execute the default operation software contained in ROM for baseline operation. Another method of prohibiting downloaded firmware from being executed is to send an "Accept Firmware Download" command immediately followed by a "Return to Primary Channel" command.

The "Load Firmware Segment" command is used to download the individual segments of a firmware package. All converters receiving this command, if in firmware reception mode, overwrite the appropriate segment of firmware by the received data. Before actually overwriting the code, the converter checks to see if the package number matches the commanded package number, and calculates the segment check pattern from the received data. If the check pattern is correct, the segment data is decrypted, the appropriate prior segment is overwritten with the new segment, and the appropriate bit in the firmware segment bit map is set.

The "Check/Execute Firmware" command is used to terminate the firmware download process. All converters receiving this command respond only if the package number matches the one sent originally in the "Accept Firmware Download" command, and if in firmware reception mode. If so, the converter checks to see if all of the necessary segments of firmware have been correctly received. If they have been, the package check pattern is calculated and tested. If the check pattern is bad, the converter ignores the command. If the check pattern is good, the converter permits execution of the newly downloaded package, switches back to the primary data stream, exits the firmware download mode, and clears its firmware download segment bit map.

The "Send Firmware Check Pattern" command is used to verify the firmware download process. A converter receiving this command responds only if it is not in firmware reception mode. In this event, the converter reports the check pattern of the appropriate segment or of the entire package. This verification scheme is only available on a two-way cable system.

Figure 6 illustrates a periodic self-check routine used by the converter to test the validity of downloaded firmware to ensure that it has not changed since the last download. This self-check is performed by the converter itself, and no addressable controller command is required to initiate it. The routine begins at box 150. At box 152, a clock runs to keep track of time. At box 154, a determination is made as to whether a predetermined time interval has passed. If not, the routine loops back to box 152 and the process continues until the time interval has run. Then, box 154 passes control to box 156 to commence the periodic self-check.

At box 156, the first segment of the firmware package is tested by computing its checksum. At box 158, a determination is made as to whether the checksum is the proper checksum for that segment. If not, control passes to box 160 and the default operation software is executed to return the converter to baseline operation. If the checksum for the segment is proper, control passes to box 162, which determines if the segment just tested is the last segment in the firmware package. If not, the routine loops back to box 156 so that all of the segments in the firmware package can be tested.

Once the last segment has been tested, control is passed from box 162 to box 164 where the clock is reset.

Control then loops back to box 152 and the process continues, so that the self-check will be periodically performed at the time interval dictated by the time-out determination function at box 154.

It will now be appreciated that the present invention provides a method and apparatus for remotely modifying the functionality of a terminal, such as a cable television converter. Terminal functions are dictated by downloaded firmware. The firmware is transmitted in small segments to reduce the likelihood and severity of transmission errors, and to reduce the temporary buffering requirements within the terminal. Each section of a firmware package is transmitted with an identifier indicating which segment it is, and which firmware package it is part of. A multiplicity of firmware packages may be carried on a single system, with different terminals in the system accepting and executing different packages as specified by the system headend.

The firmware is stored at the terminal in nonvolatile memory, such as RAM with a battery backup. Various safeguards are provided to ensure that the firmware is accurately downloaded, and to frustrate the efforts of a software pirate attempting to infiltrate the system.

Claims

1. A remotely controllable cable television converter (40) which is able to operate in a baseline mode allowing the reception of a television program and which, upon receipt of functional operating software (firmware) downloaded from a remote cable television headend (10), can be provided with higher levels of converter functions resulting in an increased converter functionality in addition to said baseline mode, said converter comprising:

   means (52, 50) for receiving said functional operating software (firmware) downloaded from said remote cable television headend (10);

   means (60) coupled to said receiving means for storing said downloaded functional operating software (firmware);

   means (50) for verifying said downloaded functional operating software (firmware);

   processor means (50) coupled to said storing means (60) for accessing and executing said downloaded functional operating software (firmware);

   nonvolatile memory means (56) coupled to said processor means (50) for storing default operation software, said default operation software providing said baseline mode operation to said converter (40); and

   means (50) responsive to said verifying means (50) for causing said processor means to execute said default operation software instead of said downloaded functional operating software (firmware) in the event the downloaded software is invalid or contains errors.

2. The converter of claim 1, wherein said receiving means comprise data receiving means (52) for obtaining specific instruction data downloaded from said cable television headend (10), said data receiving means enabling said receiving means only in response to said specific instruction data.

3. The converter of claim 2 wherein said data receiving means comprise:

   a frequency tunable data receiver (52); and

   means (54) for selectively tuning said receiver (52) to receive said instruction data on a first channel and said functional operating software (firmware) on a second channel.

4. The converter of claim 3 further comprising:
   timer means (64) for returning said receiver (52) to said first channel if it has been tuned to said second channel for a predetermined time period.

5. The converter of claim 4 wherein said predetermined time period is specified in instructions received on said first channel.

6. The converter of claim 5 wherein the length of said predetermined time period is dependent on an amount of said functional operating software (firmware) to be received.

7. The converter as defined in one of claims 1 to 6 wherein said functional operating software (firmware) implements a functional layout on a keyboard (68) associated with said converter (40).

8. The converter as defined in one of claims 1 to 7 wherein said functional operating software (firmware) implements a feedback function to assist a user in operating said converter (40).

9. The converter as defined in one of claims 1 to 8 wherein said functional operating software (firmware) implements a control function for a video recorder coupled to said converter (40).

10. The converter as defined in one of claims 1 to 9 wherein said functional operating software (firmware) implements a communication protocol for said converter (40).

11. The converter as defined in one of claims 1 to 10 wherein said functional operating software (firmware) implements a descrambling technique for said converter (40).

12. The converter as defined in one of claims 1 to 11 wherein said functional operating software (firmware) implements an on-screen display to be provided by said converter (40) to a television set (44) coupled thereto.

13. The converter as defined in one of claims 1 to 12 wherein said functional operating software (firmware) implements a user interface to services provided over a cable television network.

14. The converter as defined in one of claims 1 to 13 wherein said functional operating software (firmware) implements an electronic mail capability to be provided over a cable television network.

15. The converter as defined in one of claims 1 to 14 wherein said functional operating software (firmware) implements a viewership monitoring function.

16. The converter as defined in one of claims 2 to 15 wherein said functional operating software (firmware) is transmitted in an encrypted form, and said instruction data contain a key for decrypting said functional operating software (firmware).

17. The converter as defined in one of claims 2 to 16 wherein said functional operating software (firmware) is received in a plurality of segments, and said instruction data identify the number of segments to be received for a complete functional operating software download.

18. The converter of claim 17 further comprising:

    means (50) for determining if all of said segments have been validly received; and

    means for receiving replacement segments if one or more segments of said functional operating software (firmware) has not been validly received.

19. The converter as defined in one of claims 17 or 18 further comprising:
    means (50) for preventing the receipt of said functional operating software (firmware) if the number of segments identified by said instruction data is greater than a predetermined limit.

20. The converter as defined in one of claims 1 to 19 wherein said verifying means (50) are verifying said downloaded functional operating software (firmware) after it has been stored.

Patentansprüche

1. Fernbedienbarer Kabelfernsehkonverter (40), welcher in einem Grundlinien-Modus arbeiten kann, der den Empfang eines Fernsehprogramms erlaubt, und welcher, nach Erhalt funktioneller Betriebs-Software (Firmenware), die von einem entfernten Kabelfernseh-Kopfende (10) zugeladen wird, mit höheren Ebenen von Konverter-Funktionen versehen werden kann, welche in einer vergrößerten Konverter-Funktionalität zusätzlich zu dem Grundlinien-Modus resultiert, wobei der Konverter umfaßt:

    Mittel (52,50) zum Empfangen der funktionellen Betriebs-Software (Firmenware), welche von dem entfernten Kabelfernseh-Kopfende (10) zugeladen wird;

    Mittel (60), die an die empfangenden Mittel zum Speichern der zugeladenen funktionellen Betriebs-Software (Firmenware) angekoppelt sind;

    Mittel (50) zum Verifizieren der zugeladenen funktionellen Betriebs-Software (Firmenware);

    Prozessor-Mittel (50), welche an die speichernden Mittel (60) angekoppelt sind, zum Zugreifen auf und Ausführen der zugeladenen funktionellen Betriebs-Software (Firmenware);

    Nichtflüchtig-Speicher-Mittel (56), die an die Prozessor-Mittel (50) angekoppelt sind, zum Speichern von Vorgabe-Betriebssoftware, wobei die Vorgabe-Betriebssoftware dem Konverter (40) den Grundlinienmodus-Betrieb bereitstellt; und

    Mittel (50), die auf die verifizierenden Mittel (50) ansprechen, um die Prozessor-Mittel zu veranlassen, die Vorgabe-Betriebs-Software anstatt der zugeladenen funktionellen Betriebs-Software (Firmenware) auszuführen im Falle, daß die zugeladene Software ungültig ist oder Fehler enthält.

2. Konverter nach Anspruch 1, wobei die empfangenden Mittel datenempfangende Mittel (52) zum Erhalten von spezifischen Instruktionsdaten, welche von dem Kabelfernseh-Kopfende (10) zugeladen werden, umfassen, wobei die datenempfangenden Mittel die empfangenden Mittel nur als Antwort auf die spezifischen Instruktionsdaten ermächtigen.

3. Konverter nach Anspruch 2, wobei die datenempfangenden Mittel umfassen:

einen frequenz-abstimmbaren Datenempfänger (52); und

Mittel (54) zum Abstimmen des Empfängers (52) auf selektive Weise, um die Instruktionsdaten auf einem ersten Kanal zu empfangen und die funktionelle Betriebs-Software (Firmenware) auf einem zweiten Kanal.

4. Konverter nach Anspruch 3, welcher weiter umfaßt: Zeitgeber-Mittel (64) zum Bewirken der Rückkehr des Empfängers (52) auf den ersten Kanal, wenn er auf den zweiten Kanal für eine vorbestimmte Zeitdauer abgestimmt worden ist.

5. Konverter nach Anspruch 4, wobei die vorbestimmte Zeitdauer in Instruktionen spezifiziert ist, die auf dem ersten Kanal empfangen werden.

6. Konverter nach Anspruch 5, wobei die Länge der vorbestimmten Zeitdauer abhängig ist von einem Umfang der funktionellen Betriebs-Software (Firmenware), die empfangen werden soll.

7. Konverter nach einem der Ansprüche 1 bis 6, wobei die funktionelle Betriebs-Software (Firmenware) ein funktionelles Lay-out auf einer Tastatur (68), die mit dem Konverter (40) assoziiert ist, implementiert.

8. Konverter nach einem der Ansprüche 1 bis 7, wobei die funktionelle Betriebs-Software (Firmenware) eine Rückkopplungsfunktion implementiert, um einem Benutzer bei der Bedienung des Konverters (40) zu helfen.

9. Konverter nach einem der Ansprüche 1 bis 8, wobei die funktionelle Betriebs-Software (Firmenware) eine Kontrollfunktion für einen Videorecorder implementiert, der an den Konverter (40) gekoppelt ist.

10. Konverter nach einem der Ansprüche 1 bis 9, wobei die funktionelle Betriebs-Software (Firmenware) ein Kommunikationsprotokoll für den Konverter (40) implementiert.

11. Konverter nach einem der Ansprüche 1 bis 10, wobei die funktionelle Betriebs-Software eine Entschlüsselungsmethode für den Konverter (40) implementiert.

12. Konverter nach einem der Ansprüche 1 bis 11, wobei die funktionelle Betriebs-Software (Firmenware) eine Bildschirmanzeige implementiert, welche durch den Konverter (40) an ein daran gekoppeltes Fernsehgerät (44) bereitgestellt wird.

13. Konverter nach einem der Ansprüche 1 bis 12, wobei die funktionelle Betriebs-Software (Firmenware) eine Benutzer-Schnittstelle zu Diensten, die über ein Kabelfernseh-Netzwerk bereitgestellt werden, implementiert.

14. Konverter nach einem der Ansprüche 1 bis 13, wobei die funktionelle Betriebs-Software (Firmenware) eine Fähigkeit für elektronische Briefe (Mail) implementiert, welche über ein Kabelfernseh-Netzwerk bereitgestellt wird.

15. Konverter nach einem der Ansprüche 1 bis 14, wobei die funktionelle Betriebs-Software (Firmenware) eine Zuschauerschaft-Überwachungsfunktion implementiert.

16. Konverter nach einem der Ansprüche 2 bis 15, wobei die funktionelle Betriebs-Software (Firmenware) in einer verschlüsselten Form übertragen wird und die Instruktionsdaten einen Schlüssel zum Entschlüsseln der funktionellen Betriebs-Software (Firmenware) enthalten.

17. Konverter nach einem der Ansprüche 2 bis 16, wobei die funktionelle Betriebs-Software (Firmenware) in einer Mehrzahl von Segmenten empfangen wird, und wobei die Instruktionsdaten die Anzahl der Segmente, die für eine vollständige funktionelle Betriebs-Software-Zuleitung empfangen werden sollen, identifizieren.

18. Konverter nach Anspruch 17, der weiter umfaßt:

Mittel (50) zum Bestimmen, ob jedes der Segmente richtig empfangen worden ist; und

Mittel zum Empfangen von Ersetzungssegmenten, wenn ein oder mehrere Segmente der funktionellen Betriebs-Software (Firmenware) nicht auf richtige Weise empfangen worden sind.

19. Konverter nach Anspruch 17 oder 18, welcher weiter umfaßt:
Mittel (50) zum Verhindern des Empfangs der funktionellen Betriebs-Software (Firmenware), wenn die Anzahl der Segmente, welche durch die Instruktionsdaten identifiziert werden, größer als ein vorbestimmter Grenzwert ist.

20. Konverter nach einem der Ansprüche 1 bis 19, wobei die verifizierenden Mittel (50) die zugeladene funktionelle Betriebs-Software (Firmenware) verifizieren, nachdem sie gespeichert wurde.

Revendications

1. Convertisseur (40) de télévision par câble, qui peut être commandé à distance, qui peut fonctionner dans un mode de ligne de référence, permettant la réception d'un programme de télévision, et qui, à la réception d'un logiciel (microprogramme) d'exploitation fonctionnel transféré depuis une extrémité amont (10) éloignée de télévision par câble, peut être muni de niveaux supérieurs de fonctions de convertisseur donnant lieu en une fonctionnalité accrue du convertisseur, en supplément au mode à ligne de référence, le convertisseur comprenant :

   des moyens (52, 50) pour recevoir le logiciel (microprogramme) d'exploitation fonctionnel transféré depuis l'extrémité amont (10) éloignée de télévision par câble,
   des moyens (60) raccordés aux moyens de réception précités en vue de mémoriser le logiciel (microprogramme) d'exploitation fonctionnel transféré,
   des moyens (50) pour vérifier le logiciel (microprogramme) d'exploitation fonctionnel transféré,
   des moyens de traitement (50) raccordés aux moyens de mémorisation (60) afin d'accéder à et d'exécuter le logiciel (microprogramme) d'exploitation fonctionnel transféré,
   des moyens de mémorisation rémanente (56) raccordés aux moyens de traitement (50) en vue de mémoriser un logiciel d'exploitation par défaut, le logiciel d'exploitation par défaut fournissant au convertisseur (40) ledit fonctionnement en mode à ligne de référence, et
   des moyens (50) qui répondent aux moyens de vérification (50) pour amener les moyens de traitement à exécuter le logiciel de fonctionnement par défaut au lieu du logiciel (microprogramme) d'exploitation fonctionnel transféré, au cas où le logiciel transféré n'est pas valide ou contient des erreurs.

2. Convertisseur suivant la revendication 1, caractérisé en ce que les moyens de réception comprennent des moyens (52) de réception de données en vue d'obtenir des données d'instruction spécifiques transférées depuis l'extrémité amont (10) de la télévision par câble, les moyens de réception de données ne validant les moyens de réception qu'en réponse auxdites données d'instruction spécifiques.

3. Convertisseur suivant la revendication 2, caractérisé en ce que les moyens de réception de données comprennent :

   un récepteur de données (52) accordable en fréquence, et
   des moyens (54) afin d'accorder sélectivement le récepteur (52) pour recevoir les données d'instruction sur un premier canal et le logiciel (microprogramme) d'exploitation fonctionnel sur un second canal.

4. Convertisseur suivant la revendication 3, caractérisé en ce qu'il comprend en outre :
   des moyens de temporisation (64) pour ramener le récepteur (52) sur le premier canal s'il a été accordé sur le second canal pour une période de temps prédéterminée.

5. Convertisseur suivant la revendication 4, caractérisé en ce que la période de temps prédéterminée est précisée dans des instructions reçues sur le premier canal.

6. Convertisseur suivant la revendication 5, caractérisé en ce que la longueur de la période de temps prédéterminée dépend d'une valeur du logiciel (microprogramme) d'exploitation fonctionnel à recevoir.

7. Convertisseur suivant l'une des revendications 1 à 6, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel réalise une disposition fonctionnelle sur un clavier (68) associé au convertisseur (40).

8. Convertisseur suivant l'une des revendications 1 à 7, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel exécute une fonction de rétroaction afin d'aider un utilisateur à faire fonctionner le convertisseur (40).

9. Convertisseur suivant l'une des revendications 1 à 8, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel réalise une fonction de commande pour un enregistreur vidéo raccordé au convertisseur (40).

10. Convertisseur suivant l'une des revendications 1 à 9, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel exécute un protocole de communication pour le convertisseur (40).

11. Convertisseur suivant l'une des revendications 1 à 10, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel exécute une technique de désembrouillage pour le convertisseur (40).

12. Convertisseur suivant l'une des revendications 1 à 11, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel exécute un affichage sur écran à fournir par le convertisseur (40) à un ensemble de télévision (44) qui y est raccordé.

13. Convertisseur suivant l'une des revendications 1 à 12, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel réalise un interface d'utilisateur pour des services fournis sur un réseau de télévision par câble.

14. Convertisseur suivant l'une des revendications 1 à 13, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel exécute une possibilité d'expédition de courrier électronique à prévoir sur un réseau de télévision par câble.

15. Convertisseur suivant l'une des revendications 1 à 14, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel exécute une fonction de surveillance d'un ensemble de spectateurs.

16. Convertisseur suivant l'une des revendications 2 à 15, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel est transmis sous une forme codée et en ce que lesdites données d'instruction comportent une clef pour décoder le logiciel (microprogramme) d'exploitation fonctionnel.

17. Convertisseur suivant l'une des revendications 2 à 16, caractérisé en ce que le logiciel (microprogramme) d'exploitation fonctionnel est reçu dans une pluralité de segments et en ce que les données d'instruction susdites identifient le nombre de segments à recevoir pour un transfert complet de logiciel d'exploitation fonctionnel.

18. Convertisseur suivant la revendication 17, caractérisé en ce qu'il comprend en outre :

    des moyens (50) pour déterminer si tous les segments ont été reçus de façon valide, et
    des moyens pour recevoir des segments de remplacement si un ou plusieurs segments du logiciel (microprogramme) d'exploitation fonctionnel n'ont pas été reçus de façon valide.

19. Convertisseur suivant l'une des revendications 17 ou 18, caractérisé en ce qu'il comprend en outre des moyens (50) pour empêcher la réception du logiciel (microprogramme) d'exploitation fonctionnel si le nombre de segments identifié par lesdites données d'instruction est supérieur à une limite prédéterminée.

20. Convertisseur suivant l'une des revendications 1 à 19, caractérisé en ce que les moyens de vérification (50) vérifient le logiciel (microprogramme) d'exploitation fonctionnel transféré, après qu'il a été mémorisé.

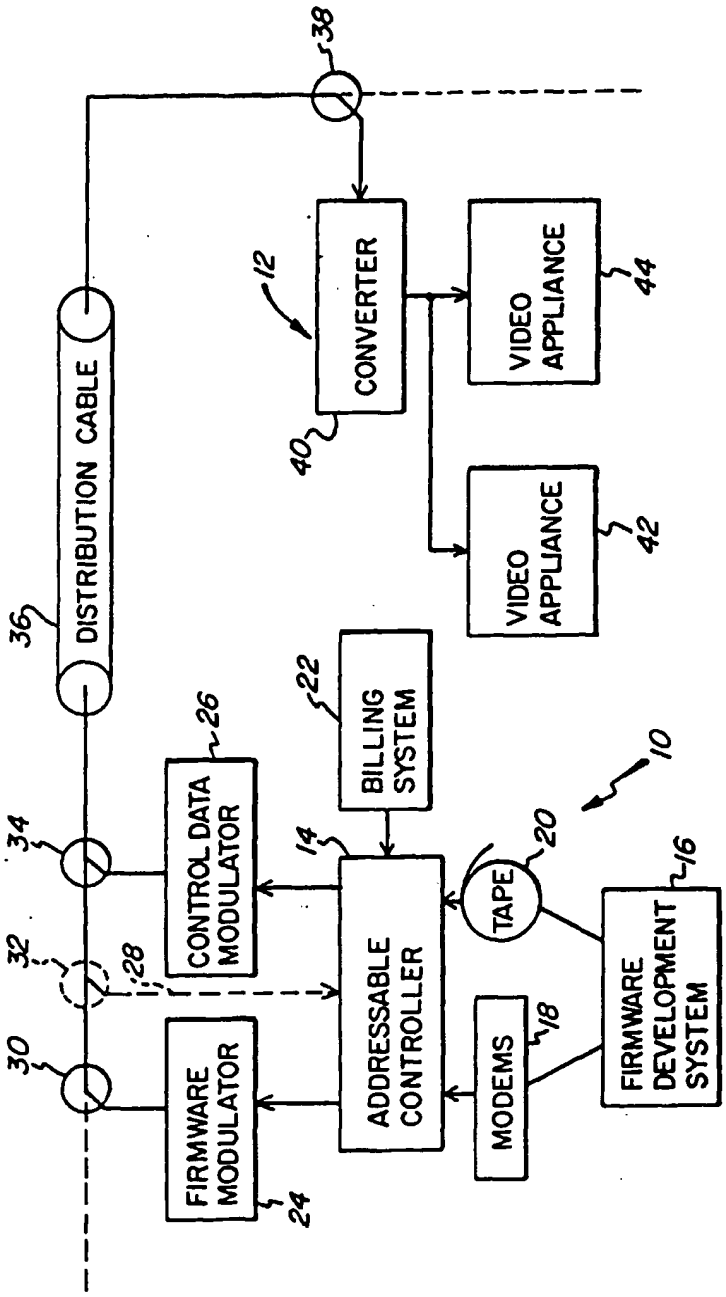
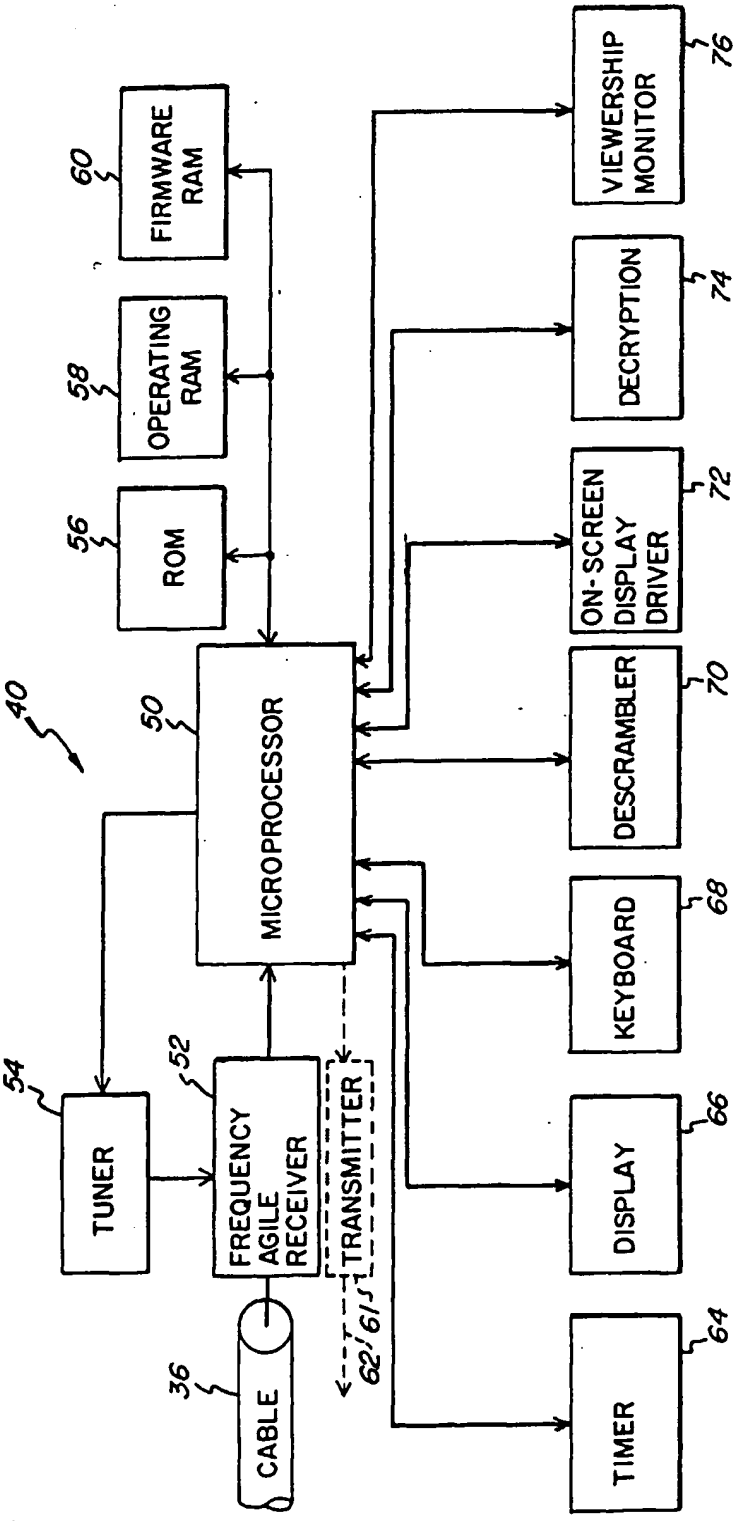

38
12
CONVERTER
VIDEO APPLIANCE
44
40
VIDEO APPLIANCE
42
36
DISTRIBUTION CABLE
22
BILLING SYSTEM
26
CONTROL DATA MODULATOR
34
14
10
20
TAPE
16
FIRMWARE DEVELOPMENT SYSTEM
32
28
30
FIRMWARE MODULATOR
ADDRESSABLE CONTROLLER
MODEMS
18
24

FIG. 1

FIG. 2


40
50
MICROPROCESSOR
60
FIRMWARE RAM
58
OPERATING RAM
56
ROM
54
TUNER
52
FREQUENCY AGILE RECEIVER
TRANSMITTER
62
61
36
CABLE
VIEWERSHIP MONITOR
76
DECRYPTION
74
ON-SCREEN DISPLAY DRIVER
72
DESCRAMBLER
70
KEYBOARD
68
DISPLAY
66
TIMER
64

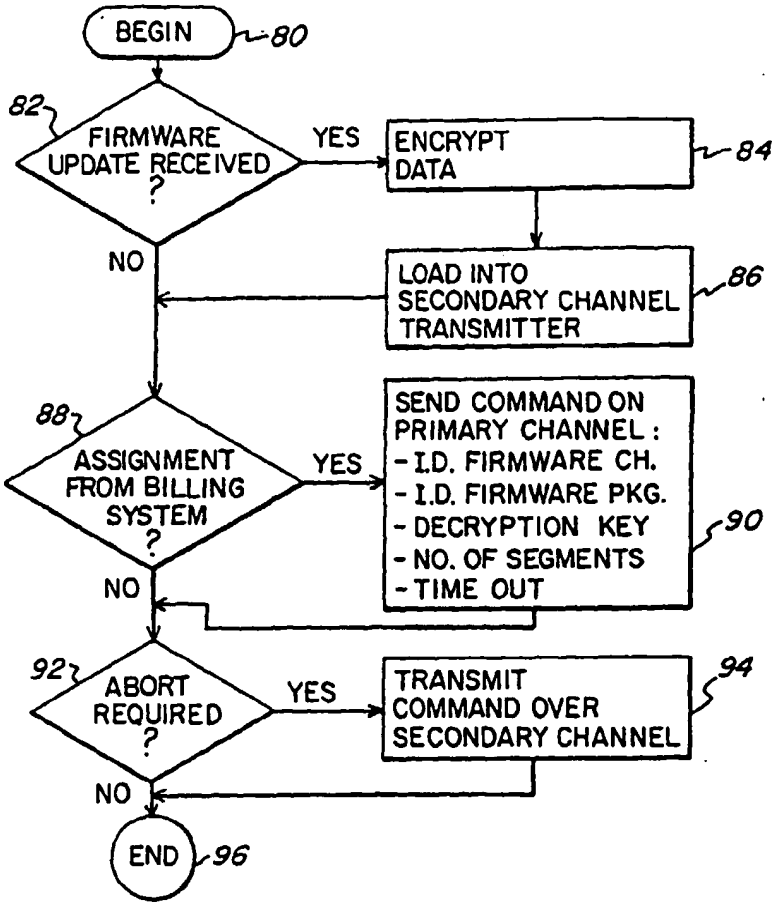

BEGIN
80
82
FIRMWARE UPDATE RECEIVED ?
YES
ENCRYPT DATA
84
NO
LOAD INTO SECONDARY CHANNEL TRANSMITTER
86
88
ASSIGNMENT FROM BILLING SYSTEM ?
YES
SEND COMMAND ON PRIMARY CHANNEL :
- I.D. FIRMWARE CH.
- I.D. FIRMWARE PKG.
- DECRYPTION KEY
- NO. OF SEGMENTS
- TIME OUT
90
NO
92
ABORT REQUIRED ?
YES
TRANSMIT COMMAND OVER SECONDARY CHANNEL
94
NO
END
96

FIG. 3

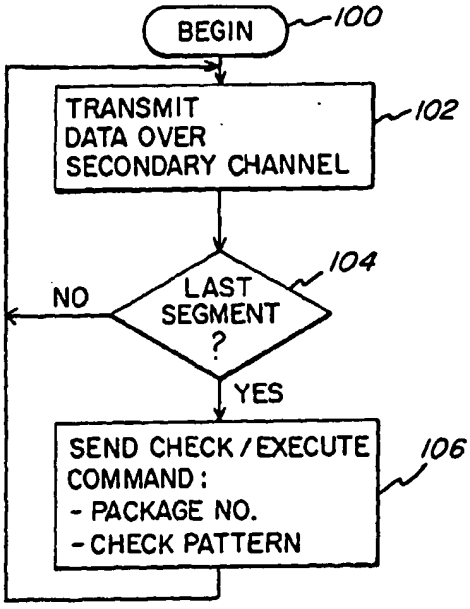

BEGIN
100
TRANSMIT DATA OVER SECONDARY CHANNEL
102
104
NO
LAST SEGMENT ?
YES
SEND CHECK / EXECUTE COMMAND :
- PACKAGE NO.
- CHECK PATTERN
106

FIG. 4

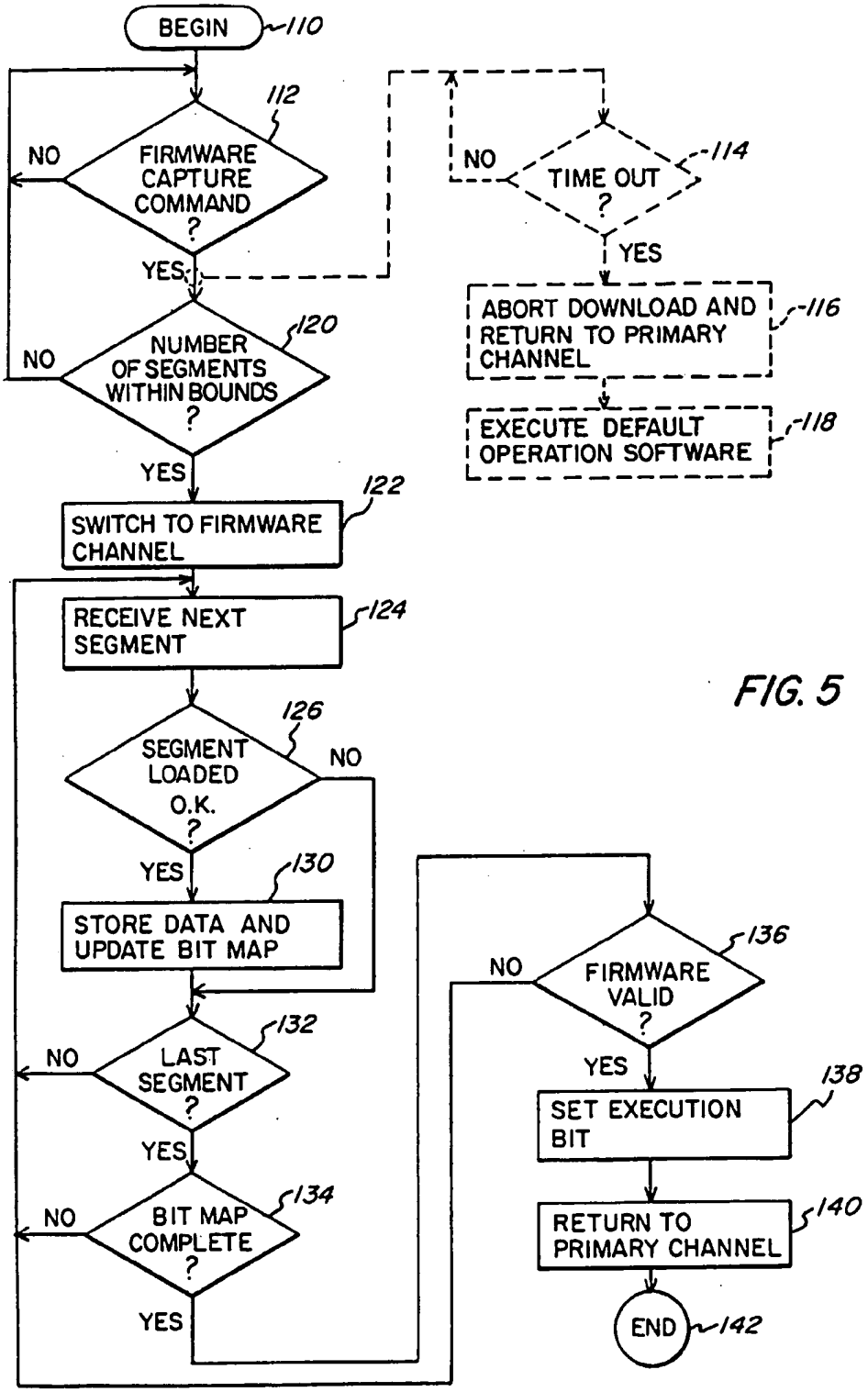

BEGIN
110
112
FIRMWARE CAPTURE COMMAND ?
NO
YES
114
TIME OUT ?
NO
YES
116
ABORT DOWNLOAD AND RETURN TO PRIMARY CHANNEL
118
EXECUTE DEFAULT OPERATION SOFTWARE
120
NUMBER OF SEGMENTS WITHIN BOUNDS ?
NO
YES
122
SWITCH TO FIRMWARE CHANNEL
124
RECEIVE NEXT SEGMENT
126
SEGMENT LOADED O.K. ?
NO
YES
130
STORE DATA AND UPDATE BIT MAP
132
LAST SEGMENT ?
NO
YES
134
BIT MAP COMPLETE ?
NO
YES
136
FIRMWARE VALID ?
NO
YES
138
SET EXECUTION BIT
140
RETURN TO PRIMARY CHANNEL
END
142

FIG. 5

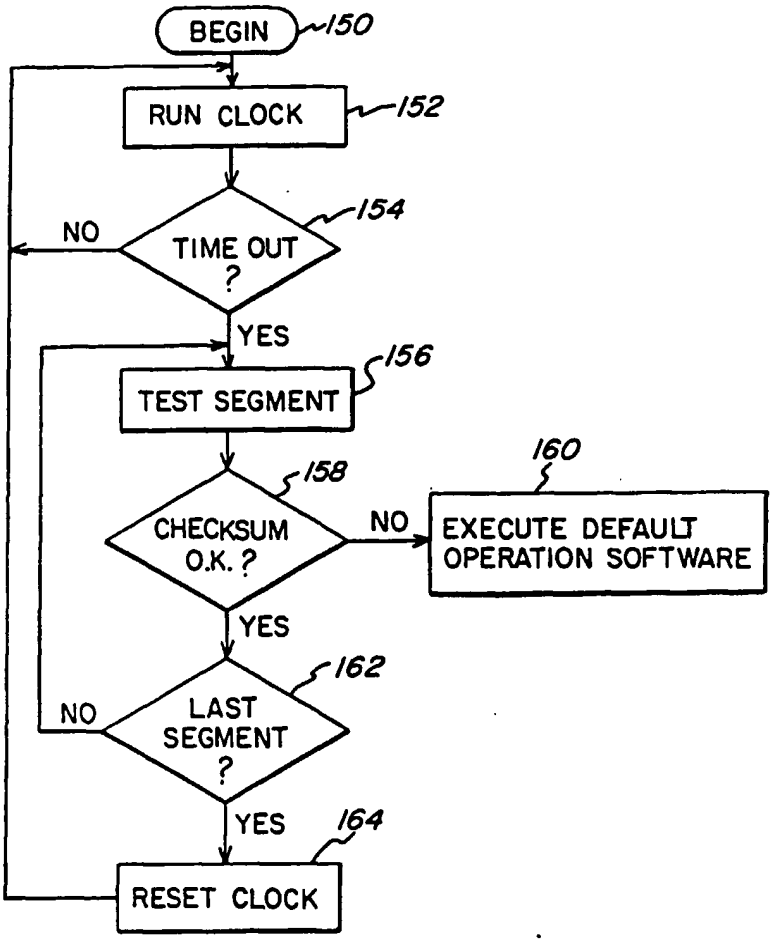

BEGIN
150
RUN CLOCK
152
TIME OUT ?
154
NO
YES
TEST SEGMENT
156
CHECKSUM O.K. ?
158
NO
160
EXECUTE DEFAULT OPERATION SOFTWARE
YES
LAST SEGMENT ?
162
NO
YES
RESET CLOCK
164

FIG. 6